

Comparative Diffraction by Thin and Thick Planetary Ring Models

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A new approach to investigate near-forward electromagnetic wave interaction with planetary ring models is the stochastic geometry, or random-screen, model (Marouf, *BAAS* 26, 1150, 1994). It relies on the assumption that particles of radius larger than the wavelength extinguish and diffract the incident radiation in a manner similar to diffraction by a randomly blocked screen; the random area blocked is determined by the shadows cast by the particles on a plane normal to the incidence direction. The model strength is its adaptability to arbitrary vertical ring profile and arbitrary particle distributions, including packing, clustering, and spatial anisotropy. The random screen model is used to comparatively investigate the scattering behavior of two extreme vertical ring profiles, namely, monolayer and many-particle-thick cases (for brevity, thin and thick models). In both cases, the total forward diffracted power is shown to depend only the fraction p of the screen area blocked. The dependence is of the form $p(1 - p)$, thus is symmetric around $p = 0.5$ (optical depth ~ 1.4), where the peak total scattered power is achieved. To characterize the angular distribution of the diffracted intensity, a phase-function-like parameter $F(\theta)$ is defined. In the thick model case, $F(\theta)$ is determined by the 2-D Fourier transform of the autocorrelation function of the random shadow area. Multiple particle shadow overlaps physically correspond to multiple scattering contributions to the scattered intensity, yielding $F(\theta)$ that differ significantly in magnitude and shape from the single-scattering phase function. In the thin model case, $F(\theta)$ remains essentially the same as the single-scattering phase function, except away from normal incidence where shadow areas in a crowded monolayer overlap, hence behavior like the thick model is expected. Analytical results obtained assuming Poisson distributed particle positions (that is, small volume fraction) are in agreement with published results based on the radiative transfer model (Marouf *et al.*, *Icarus* 54, 189-211, 1983). Numerical simulations (in progress) based on the random-screen model are being used to explore the parameter space for which no analytical results are available, including dependence on volume fraction and incidence angle.

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